TEST 2
Fall 2014
(27th November, 2014)
CIE200 – STATICS
CLOSED BOOK, 75 MINUTES

Name: Fall 2014 **ID#:** 2015**** **Section: 13**

NOTES

- 3 problems (12 pages).
- All your answers should be provided on the question sheets.
- Two extra sheets are provided at the end.
- Ask for additional sheets if you need more space.
- Some answers may require much less than the space provided.
- ***Do not*** use the back of the sheets for answers.
- ***Every FBD needed for the solution of a problem should be clearly shown.***
- ***Points will be deducted for any missing/ incomplete/incorrect FBD.***
- ***Points will be deducted for answers not supported by proper calculations.***

YOUR COMMENT(S)

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DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

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YOUR GRADE

Problem I:	30 /30
Problem II:	35 /35
Problem III	35 /35
TOTAL:	100 /100

Problem I: *(30 points)*

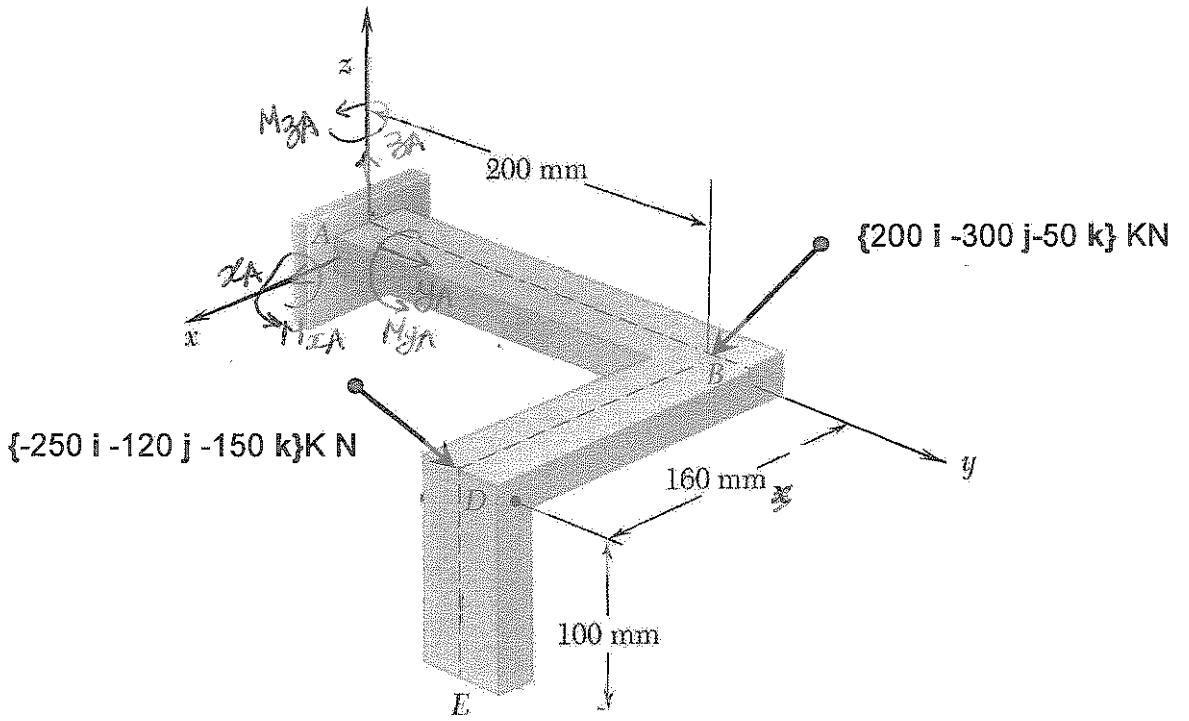


Figure I

Member ABDE shown in Figure I is supported by a fixed support at A and subjected to two forces at B and D.

1- Use vector approach, compute the reactions at the fixed support A. Express results in Cartesian vector. *(20 points).*
2- Use scalar Approach, Re-compute the reactions at the fixed support and compare with question 1. *(10 points).*

Note: FBD must be included

Calculations and/or Diagrams: Vector Approach

$\overset{+}{\leftarrow} \Sigma F_x = 0 \Rightarrow x_A - 250 + 200 = 0 \Rightarrow x_A = 50\ KN$

$\overset{+}{\rightarrow} \Sigma F_y = 0 \Rightarrow y_A - 120 - 300 = 0 \Rightarrow y_A = 420\ KN$

$+\uparrow \Sigma F_z = 0 \Rightarrow z_A - 150 - 50 = 0 \Rightarrow z_A = 200\ KN$

Coordinates: $D(0.16, 0.2, 0)$ & $B(0, 0.2, 0)$

$\vec{r}_{AD} = \{0.16\vec{i} + 0.2\vec{j} + 0\vec{k}\}^m$ & $\vec{r}_{AB} = \{0\vec{i} + 0.2\vec{j} + 0\vec{k}\}^m$

Calculations and/or Diagrams:

$$\vec{M}_A = \vec{r}_{AD} \times \vec{F}_D + \vec{r}_{AB} \times \vec{F}_B$$

$$\vec{M}_A = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0.16 & 0.2 & 0 \\ -250 & -120 & -150 \end{vmatrix} + \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0.2 & 0 \\ 200 & -300 & -50 \end{vmatrix}$$

$$\vec{M}_A = \{-30\vec{i} + 24\vec{j} + 30.8\vec{k}\} + \{-10\vec{i} + 0\vec{j} - 40\vec{k}\}$$

$$\vec{M}_A = \{-40\vec{i} + 24\vec{j} - 9.2\vec{k}\} \text{ KN.m}$$

$+\circlearrowleft \Sigma M_x = 0 \Rightarrow M_{xA} - 40 = 0 \Rightarrow M_{xA} = 40$ KN.m

$+\circlearrowright \Sigma M_y = 0 \Rightarrow M_{yA} + 24 = 0 \Rightarrow M_{yA} = -24$ KN.m

$+\uparrow \Sigma M_z = 0 \Rightarrow M_{zA} - 9.2 = 0 \Rightarrow M_{zA} = 9.2$ KN.m

In Cartesian Vector:

$$\vec{R}_A = \{50\vec{i} + 420\vec{j} + 200\vec{k}\}^{KN} \text{ & } \vec{M}_{RA} = \{-40\vec{i} - 24\vec{j} + 9.2\vec{k}\}^{KN.m}$$

2- Scalar Approach

x_A, y_A and z_A are the same as Vector approach

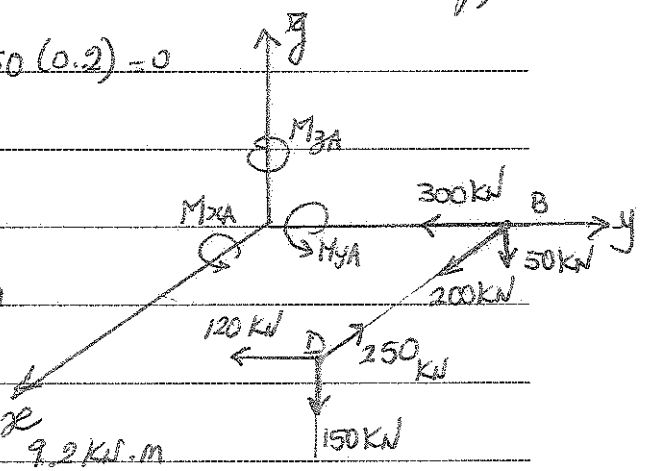
$+\circlearrowleft \Sigma M_x = 0 \Rightarrow M_{xA} - 150(0.2) - 50(0.2) = 0$

$\Sigma \quad M_{xA} = 40$ KN.m

$+\circlearrowright \Sigma M_y = 0 \Rightarrow M_{yA} + 150(0.16) = 0$

$\Rightarrow M_{yA} = -24$ KN.m

$+\uparrow \Sigma M_z = 0 \Rightarrow M_{zA} + 250(0.2) - 120(0.16) - 200(0.2) = 0 \Rightarrow M_{zA} = 9.2$ KN.m



Same as Q1. ok

Problem II: *(35 points)*

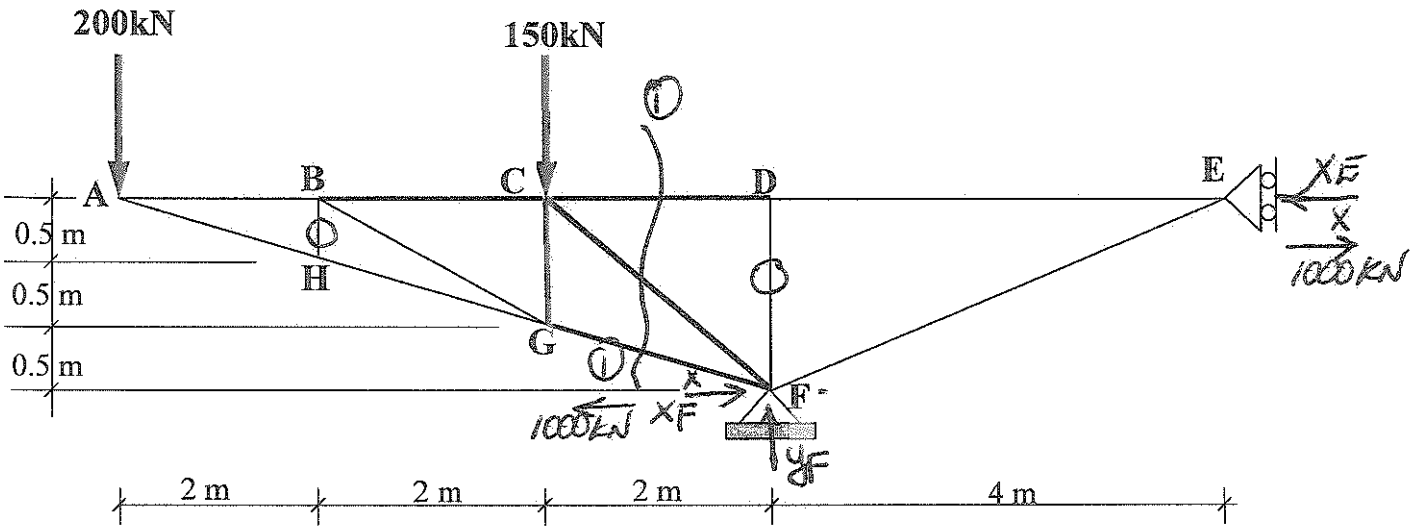


Figure II

The truss shown in Figure II is subjected to two forces at A and C:

1- Determine the external reactions at the pin support F and the roller at E. *(5 points)*
2- Determine the force in members GF, CF, and CD ***using the section method***. Also solve for the force on members CG and BC using the appropriate method of analysis. *(25 points).*
3- Indicate Zero-force members. *(5points).*

Note: FBD must be included

Calculations and/or Diagrams:

1- Reactions:

$+\circlearrowleft \Sigma M_F = 0 \Rightarrow 200(6) + 150(2) + X_E(1.5) = 0$

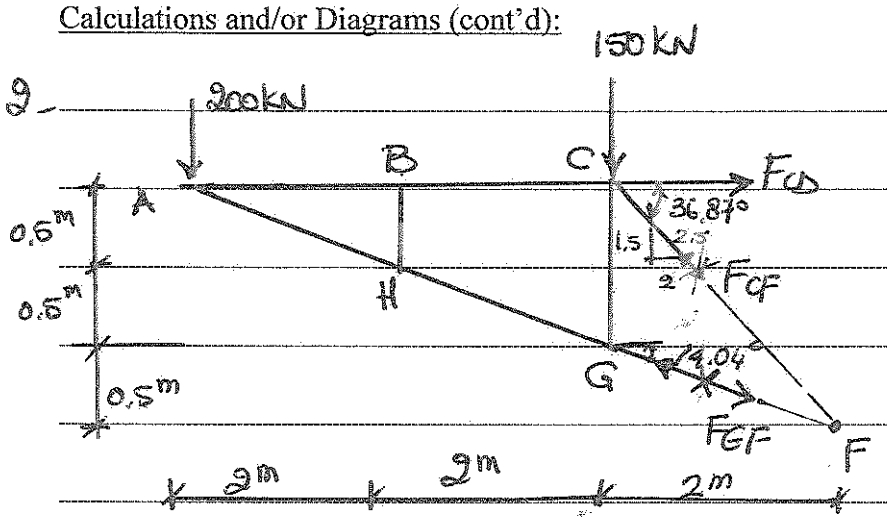
$\Rightarrow \boxed{X_E = -1000\ kN = 1000\ kN \rightarrow}$

$\pm \Sigma F_x = 0 \Rightarrow -X_F + 1000 = 0 \Rightarrow \boxed{X_F = -1000\ kN = 1000\ kN \leftarrow}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -200 - 150 + Y_F = 0 \Rightarrow \boxed{Y_F = 350\ kN \uparrow}$

Calculations and/or Diagrams (cont'd):

9-



$+\circlearrowleft \Sigma M_C = 0 \Rightarrow 200(4) + F_{GF}\cos 14.04\,(1) = 0$

$\boxed{F_{GF} = -824.64\ KN = 824.64\ KN\ (C)}$

$+\circlearrowleft \Sigma M_F = 0 \Rightarrow -F_{CD}(1.5) + 150(2) + 200(6) = 0$

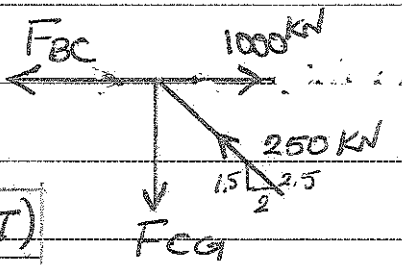
$\Rightarrow \boxed{F_{CD} = 1000\ KN\ (T)}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -200 - 150 + 824.64\sin 14.04 - F_{CF}\left(\frac{1.5}{2.5}\right) = 0$

$\boxed{F_{CF} = -250\ KN = 250\ KN\ (C)}$

$\rightarrow \Sigma F_x = 0 \Rightarrow 1000 - 250\left(\frac{2}{2.5}\right) - 824.64\cos 14.04 = 0$ V.O.K.

Equilibrium at C



$\rightarrow \Sigma F_x = 0$

$-F_{BC} + 1000 - 250\left(\frac{2}{2.5}\right) = 0$

$\Rightarrow \boxed{F_{BC} = +800\ KN = 800\ KN\ (T)}$

$+\uparrow \Sigma F_y = 0 \Rightarrow -F_{CG} + 250\left(\frac{1.5}{2.5}\right) = 0$

$\Rightarrow \boxed{F_{CG} = 150\ KN\ (T)}$

Calculations and/or Diagrams (cont'd):

3. Zero force members are BH and DF

Problem III: *(35 points)*

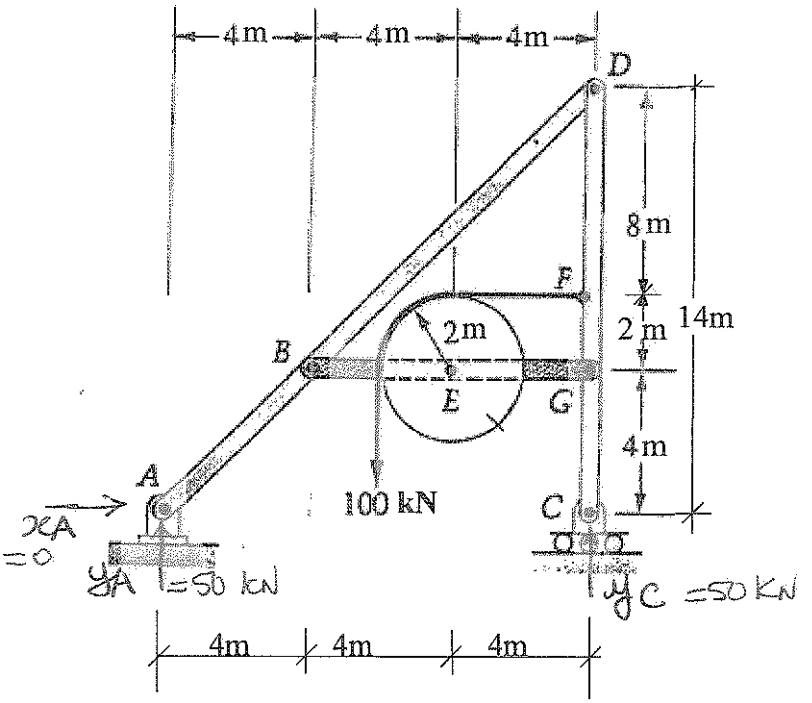


Figure III

The frame shown in Figure III is composed of three members **AD**, **CD** and **BG**, connected by pins at **B**,**D** and **G**. A frictionless pulley is attached to the member **BG** with a pin at **E**.

1. Determine the external reactions at pin support A and roller at C, and the internal forces of the frame at points B, D and G. *(35 points)*

Note: FBD must be included

Calculations and/or Diagrams:

Use the whole frame:

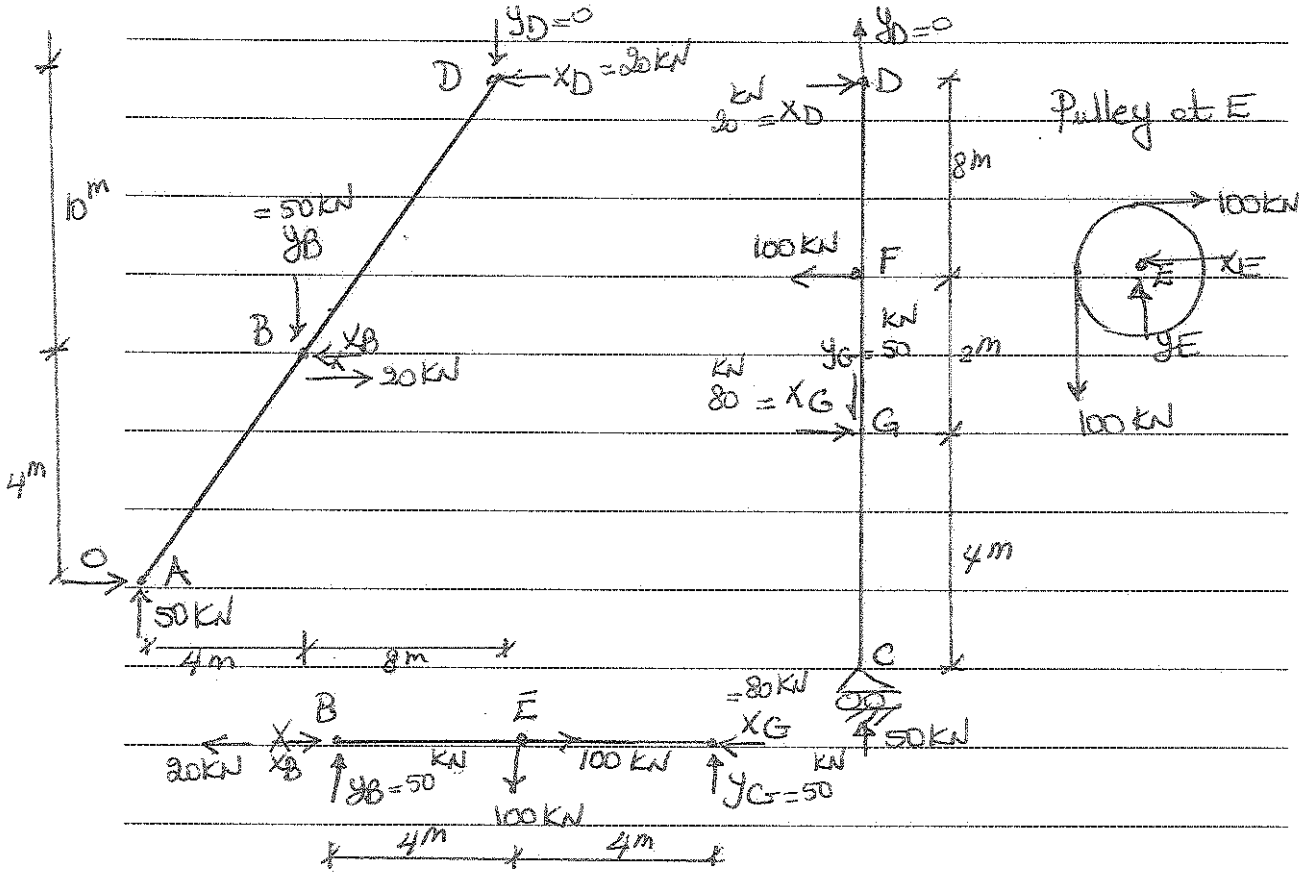
$\rightarrow \Sigma F_x = 0 \Rightarrow x_A = 0$

$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -100(6) + y_C(12) = 0 \Rightarrow y_C = 50\ KN \uparrow$

$+\circlearrowleft \Sigma M_C = 0 \Rightarrow -y_A(12) + 100(6) = 0 \Rightarrow y_A = 50\ KN \uparrow$

check $\uparrow \Sigma F_y = 0 \Rightarrow 50 - 100 + 50 = 0$ ∴ OK

Calculations and/or Diagrams (cont'd):



Pulley at E: $\pm\rightarrow \Sigma F_x = 0 \Rightarrow 100 - X_E = 0 \Rightarrow X_E = 100\,KN \leftarrow$

$+\uparrow \Sigma F_y = 0 \Rightarrow -100 + Y_E = 0 \Rightarrow Y_E = 100\,KN \uparrow$

Part CGFD:

$+\circlearrowleft \Sigma M_D = 0 \Rightarrow -100(8) + X_G(10) = 0 \Rightarrow X_G = 80\,KN \rightarrow$

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow X_D - 100 + 80 = 0 \Rightarrow X_D = 20\,KN \leftarrow$

Part BEC:

$+\circlearrowleft \Sigma M_B = 0 \Rightarrow -100(4) + Y_C(8) = 0 \Rightarrow Y_C = 50\,KN \uparrow$

$+\uparrow \Sigma F_y = 0 \Rightarrow Y_B - 100 + 50 = 0 \Rightarrow Y_B = 50\,KN \uparrow$

$\pm\rightarrow \Sigma F_x = 0 \Rightarrow X_B + 100 - 80 = 0 \Rightarrow X_B = -20\,KN = 20\,KN \leftarrow$

Calculations and/or Diagrams (cont'd):

Part ABD:

$+\uparrow \Sigma F_y = 0 \Rightarrow 50 - 50 - y_D = 0 \Rightarrow y_D = 0$

check! $\pm \Sigma F_x = 0 \Rightarrow 20 - 20 = 0$ O.K

Part CGFD:

check! $+\uparrow \Sigma F_y = 0 \Rightarrow 50 - 50 = 0$ ok.✓

check! $\pm \Sigma F_x = 0 \Rightarrow 80 - 100 + 20 = 0$ ok✓